

# README File

## EPICAERUV V0.3.6.1

Released Date: March 1 2018

### 1. Overview

The NASA EPIC aerosol data products generated by the EPICAERUV algorithm (version 0.3.6.1) are aerosol extinction optical depth (AOD), aerosol absorption optical depth (AAOD), and single scattering albedo (SSA) at 340, 388 and 500 nm. In addition, the UV Aerosol Index (UVAI) is calculated from 340 and 388 nm radiances.

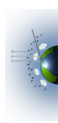
AOD is a dimensionless measure of the extinction of light by aerosols due to the combined effect of scattering and absorption, while AAOD is that only due to aerosol absorption. The AI is simply a residual parameter that quantifies the difference in spectral dependence between measured and calculated near UV radiances assuming a purely molecular atmosphere. Because most of the observed residuals are associated with the presence of absorbing aerosols, this parameter is commonly known as the UV Aerosol Index (UVAI).

The EPICAERUV retrieval algorithm uses a set of aerosol models to account for the presence of carbonaceous aerosols from biomass burning (BIO), desert dust (DST), and sulfate-based (SLF) aerosols in Table 1. The optical depth and single scattering albedo values at 388 nm are inverted from radiance observations. Conversions to 340 and 500 nm are carried out to facilitate comparisons with measurements from other space-borne and ground based sensors, as well as with model calculations, which often report values at 500 nm. Because this transformation relies on the spectral dependence of the aerosol models assumed in the algorithm, the reported values at the other wavelengths, particularly those at 500 nm, should be considered less reliable.

For environments where cloud free conditions prevail, AOD can be reliably retrieved. Cloud interference with the satellite retrieval is minimal over arid and semi-arid regions where dust aerosols are commonly present. Clear skies are also frequent in areas of seasonal biomass burning and forest fires in the vicinity of the sources. As the plumes of dust and smoke aerosols drift away from their source regions, they mix with clouds and the AOD retrieval becomes very challenging. Because of the large sensitivity of the EPIC near UV observations to particle absorption, the AAOD is the most reliable quantitative EPICAERUV aerosol parameter.

The UVAI has become an invaluable tool for tracking long-range transport of absorbing aerosols (smoke and dust) throughout the globe, even when the aerosols are over clouds. The UVAI has been instrumental in the discovery of important aspects of aerosol transport both horizontally and vertically. For instance, UVAI observations indicate that smoke aerosol plumes generated by boreal forest fires at mid and high latitudes are associated with the formation of pyro-cumulonimbus clouds capable of transporting carbonaceous aerosols to the lower stratosphere.

This document provides a brief description of the EPICAERUV Level-2 aerosol data products derived from observations by the Earth Polychromatic Imaging Camera (EPIC) onboard NOAA's DSCOVR (Deep Space Climate Observatory) spacecraft. Each file contains a single frame of 2048 x 2048 elements acquired at every 1- 2 hour interval covering the sunlit portion of the Earth from the Lagrange-1 (L-1) position with approximately 12 x 12 km<sup>2</sup> ground resolution. Ancillary information used in the inversion procedure is also included in the file.



The information in this README file applies only to the public release of the EPICAERUV data from EPIC L-1B (r02) files. As subsequent data versions are produced and released, the README file will be updated accordingly to reflect the latest algorithm modifications and data quality assessments.

## 2. V0.3.6.1 EPIC Aerosol Algorithm Description

The EPICAERUV aerosol algorithm currently uses the measurements made at two wavelengths: 340 and 388 nm. This is partly to maintain heritage with similar algorithm used for TOMS [Torres *et al*, 1998], and partly because of a lack of reliable surface reflectance data at the longer EPIC wavelengths.

### 2.1 Ancillary Information

#### 2.1.1 Surface Albedo

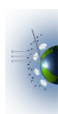
Global climatological data sets of Lambertian surface reflectivity ( $R_{SFC}$ ) at 331, 340, 360, and 380 nm are used to account for surface effects in the algorithms. It was obtained using a multi-year record of scene reflectivity ( $R_{SCE}$ ) obtained from N7-TOMS observations. For a Lambertian reflecting surface the satellite measured radiance at the top of the atmosphere can be estimated using the Chandrasekar approximation (Equation 1),

$$I^{obs} = I^0 + \frac{RT}{1 - S_b R} \quad (1)$$

where  $I^{obs}$  represents the satellite measured radiance and,  $I^0$ ,  $T$ , and  $S$  are respectively the modeled path radiance, the two-way transmittance, and the spherical albedo of a molecular atmosphere, and  $R$  is simply the Lambertian reflectivity of the of bottom of the atmospheric column that in addition to the actual surface, also includes clouds and aerosol effects. Scene Lambert Equivalent Reflectivity (LER) values at 331, 340, 360, and 380 nm ( $R_{SCE}$ ) are calculated at every Nimbus 7 TOMS pixel for a purely molecular atmosphere model solving for the  $R$  term in Equation 1 yielding

$$R_{SCE} = \frac{I^{obs} - I^0}{T + S(I^{obs} - I^0)} \quad (2)$$

Multi-year long  $R_{SCE}$  records from N7-TOMS (1979-1992) observations have been used to create monthly climatologies of surface reflectivity ( $R_{SFC}$ ) using the approach described below.



Over land, monthly  $R_{SFC}$  values are estimated as the minimum observed  $R_{SCE}$  over the multi-year TOMS records. Resulting values for every month of the year averaged over a  $1.0^\circ \times 1.0^\circ$  geographical grid.

The ocean surface reflectivity is estimated in a similar way as over land with the addition of a correction for the Sun's specular reflection. The satellite derived  $R_{SCE}$  under cloud-free conditions over the ocean is approximated as the sum of two terms: a Lambert-equivalent Fresnel reflectivity ( $R_F$ ) term and a second reflectivity term associated with water-leaving reflectance ( $R_W$ ). The  $R_F$  term is obtained by calculating the upwelling radiance at the top of the atmosphere using an atmosphere-ocean radiative transfer model [Cox and Munk, 1954] for a chlorophyll-free ocean. The calculated radiance is then converted to LER using an equation similar to Eq. 1, in which the calculated radiance is used in lieu of the observed one. The  $R_F$  thus calculated varies with solar zenith, view zenith and azimuth angles.  $R_W$  is estimated empirically by subtracting  $R_F$  from  $R_{SCE}$ . The resulting minimum  $R_W$  values per grid per month are assumed here to represent the ocean  $R_{SFC}$ .

### 2.1.2 Aerosol Layer Height

The height above the surface of absorbing aerosol layers (desert dust and smoke particles) is given by a climatological data set derived from CALIOP observations [Torres *et al.*, 2013]. Although the climatology covers most regions of the globe where seasonally varying atmospheric loads of desert dust and carbonaceous aerosols are known to reside, there are cases where the CALIOP data base does not provide height information. In those instances, the height of desert dust (DST) aerosol layers is taken from a GOCART-generated climatology [Ginoux *et al.*, 2001]. A detailed description of aerosol layer height determination is given in Section 2.3.4.

### 2.1.3 AIRS Carbon Monoxide (CO) Data

Since CO is the main gaseous component of biomass burning emissions, it constitutes a reliable tracer of carbonaceous aerosol plumes. Total column CO measurements in molecules- $\text{cm}^{-2}$  have been reported by the Atmospheric Infrared Sounder (AIRS) on the Eos-Aqua satellite. As used in TOMS and OMI aerosol algorithms, the Version 6 AIRS3STD CO total column in molecules- $\text{cm}^{-2}$  is reduced to a unit-less index (COI), by dividing the AIRS reported CO measurement by  $10^{18}$  molecules- $\text{cm}^{-2}$ . A monthly COI climatology based on multi-year (2003-2015) CO observations has been produced to aid in the identification of carbonaceous aerosols [Torres *et al.*, 2013]. The CO climatology is used retroactively as a proxy of the prevailing monthly average CO spatial distribution. Climatological COI values are used in the EPIC aerosol algorithm as discussed in Section 2.2.

## 2.2 Aerosol Retrievals

### 2.2.1 UV Aerosol Index and Cloud Fraction



UVAI is a measure of the departure of the *observed* spectral dependence of the near-UV upwelling radiation at the top of the actual Earth surface-atmosphere system from that *calculated* for a hypothetical pure molecular atmosphere bounded at the bottom by a wavelength independent Lambertian surface. UVAI is calculated as shown in Eq. 3, where  $\lambda$  and  $\lambda_0$  are wavelengths of 340 and 388 nm, respectively.  $\lambda_0$  is the reference wavelength whereas  $\lambda$  is the wavelength at which UVAI is calculated.

$$UVAI = -100 \left\{ \log \left[ \frac{I_{\lambda}^{obs}}{I_{\lambda_0}^{obs}} \right] - \log \left[ \frac{I_{\lambda}^{cal}}{I_{\lambda_0}^{cal}} \right] \right\} = -100 \log \left[ \frac{I_{\lambda}^{obs}}{I_{\lambda}^{cal}} \right] \quad (3)$$

The calculated radiances are obtained by assuming that the radiance measured by the sensor at pixel level emanates from a combination of clear and cloudy conditions ( $I_{\lambda}^s$  and  $I_{\lambda}^C$ ) involving a cloud of fixed optical depth and varying cloud fraction. The  $I_{\lambda}^s$  term is calculated from the Chandrasekar equation using as input the wavelength dependent climatological values of surface albedo (derived as explained in Section 2.1.1) and a pure molecular atmospheric model for surface pressured adjusted for topography. The  $I_{\lambda}^C$  terms, on the other hand, are calculated using Mie scattering theory for an assumed water cloud model [Deirmendjian, 1964] and wavelength-dependent refractive index [Hale and Querry, 1973], at prescribed top and bottom levels (700 and 800 hPa), and fixed cloud optical depth (COD) of 10. The choice of COD value of 10 is based on the highest frequency of occurrence of this value reported by MODIS observations [King *et al.*, 2013]. A wavelength independent radiative cloud fraction,  $f_C$ , is calculated from equation

$$f_C = \frac{I_{\lambda_0}^{obs} - I_{\lambda_0}^s}{I_{\lambda_0}^C - I_{\lambda_0}^s} \quad (4).$$

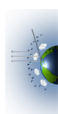
When the resulting cloud fraction is larger than unity, overcast sky conditions are assumed (i.e.,  $f_C=1.0$ ), and a new  $I_{\lambda}^C$  term for COD value larger than 10 that matches  $I_{\lambda_0}^{obs}$  is derived.  $I_{\lambda}^{cal}$  values are then obtained by linearly combining the clear and cloudy sky contributions:

$$I_{\lambda}^{cal} = (1.0 - f_C)I_{\lambda}^s + f_C I_{\lambda}^C \quad (5),$$

For snow/ice conditions at the surface, a Lambertian reflectivity term is calculated as

$$R_{\lambda_0} = \frac{I_{\lambda_0}^{obs} - I_{\lambda_0}^0}{T_{\lambda_0} + S_{\lambda_0}(I_{\lambda_0}^{obs} - I_{\lambda_0}^0)} \quad (6).$$

The terms in Eq. 6 have been defined in Section 2.1. The calculated radiance is then obtained from the expression



$$I_{\lambda}^{cal} = I_{\lambda}^0 + \frac{R_{\lambda_0} T_{\lambda}}{1 - S_{\lambda} R_{\lambda_0}} (7),$$

where a wavelength-independent Lambertian reflectivity has been assumed. The output of this calculation is then fed into Eq. 3 to calculate UVAI. If a snow or ice fraction is available, UVAI is calculated as a weighted combination of the resulting UVAI's using Equations 5 and 7 for obtaining the calculated component.

Near-zero values of UVAI result when the radiative transfer processes accounted for in the simple Rayleigh scattering model adequately explain the observations. For a well-calibrated sensor, the non-zero UVAI values are produced solely by geophysical effects, of which absorbing aerosols are by far the most important. Non-absorbing aerosols yield small negative UVAI values but the difficulty to separate the non-absorbing aerosol signal from other non-aerosol related effects limits its usefulness.

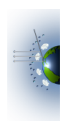
### 2.2.2 Aerosol Optical Depth and Single Scattering Albedo

In addition to the qualitative UVAI and cloud fraction parameters, the algorithm derives the aerosol optical depth (AOD) and the imaginary component of the refractive index at 388 nm. The single scattering albedo (SSA) associated with the assumed aerosol particle size distribution (PSD) and the retrieved 388 nm imaginary component of the refractive index is calculated. A set of AOD/SSA parameters is reported for pixels deemed to be free of cloud contamination. Because the current characterization of ocean reflective properties in the algorithm does not explicitly account for ocean color effects, the quality of the retrieved aerosol properties over the oceans for low aerosol amounts would be highly uncertain. For that reason, retrievals over the oceans are only carried out for high concentrations of either desert dust or carbonaceous aerosols when the *A<sub>i</sub>* values are larger than or equal to 1.0 over the oceans, *A<sub>i</sub>* values less than 1.0 are assumed to be associated with ocean color effects and/or low concentration weakly absorbing (or non-absorbing) aerosols.

## 2.3 Algorithm Description

### 2.3.1 Aerosol Models

The retrieval algorithm assumes that one of three types of aerosols can represent the column atmospheric aerosol load: desert dust (DST), carbonaceous aerosols associated with biomass burning (CRB), and sulfate-based urban-industrial aerosols (SLF). For the three aerosol types, the PSD is given by a bi-modal distribution function whose parameters are listed in Table 1. Each aerosol type is represented by seven aerosol models of varying single scattering albedo, for a total of twenty-one models. The CRB and SLF aerosol types are modeled as polydispersions of spherical particles. The DST aerosol type is modeled as spheroids [Torres *et al.*, 2017; Gassó and Torres, 2016]. Radiance look-up tables at  $\lambda$  and  $\lambda_0$  with nodal points on viewing geometry,



AOD, SSA and aerosol layer height are created using Mie Theory for spherical particles and T-matrix and Geometric Optics for spheroids [Dubovik *et al.*, 2006].

Aerosol Type	DST	CRB	SLF
Fine mode radius, $r_f$ ( $\mu\text{m}$ )	0.0520	0.0803	0.0880
Fine mode standard deviation, $\sigma_f$ ( $\mu\text{m}$ )	1.697	1.492	1.499
Minimum $r_f$ ( $\mu\text{m}$ )	0.0063	0.0162	0.0174
Maximum $r_f$ ( $\mu\text{m}$ )	0.4312	0.3971	0.4445
Coarse mode radius, $r_c$ ( $\mu\text{m}$ )	0.6700	0.7055	0.5093
Coarse mode standard deviation, $\sigma_c$ ( $\mu\text{m}$ )	1.806	2.075	2.160
Minimum $r_c$ ( $\mu\text{m}$ )	0.0630	0.0381	0.0234
Maximum $r_c$ ( $\mu\text{m}$ )	7.1276	13.0788	11.0858
Fine mode particle concentration $\#/\text{cm}^2$	13.531	13.2371	6.523
Coarse mode particle concentration $\#/\text{cm}^2$	0.0588	0.0023	0.0026
Real Refractive Index ( $n$ )	1.55	1.50	1.40
Imaginary refractive index ratio ( $k_\lambda/k_{\lambda 0}$ )	1.40	1.2	1.20

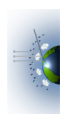
Table 1. Particle size distribution parameters and optical properties of assumed aerosol types.

Aerosol PSD parameters listed in Table 1 are based on published ground-based AERONET observations. Also listed in Table 1 are the assumed wavelength –independent real component of the refractive index, and the ratio of imaginary component of refractive index,  $k$ , between the wavelength-pairs ( $k_\lambda/k_{\lambda 0}$ ).

### 2.3.2 Aerosol type selection

Aerosol type determination is carried out based on the magnitudes of the UVAI and COI parameters as illustrated in Fig. 1.

Threshold values of UVAI ( $UVAI_0$ ) are 0.8 over land, and 1.0 over the oceans. COI threshold values ( $COI_0$ ) are 2.0 and 1.6 for the northern and southern hemisphere respectively. COI threshold values are intended to remove background upper tropospheric CO which may not



be necessarily associated with carbonaceous aerosols. A smoothing function in  $COI_0$  is used to transition from SH to NH threshold values.

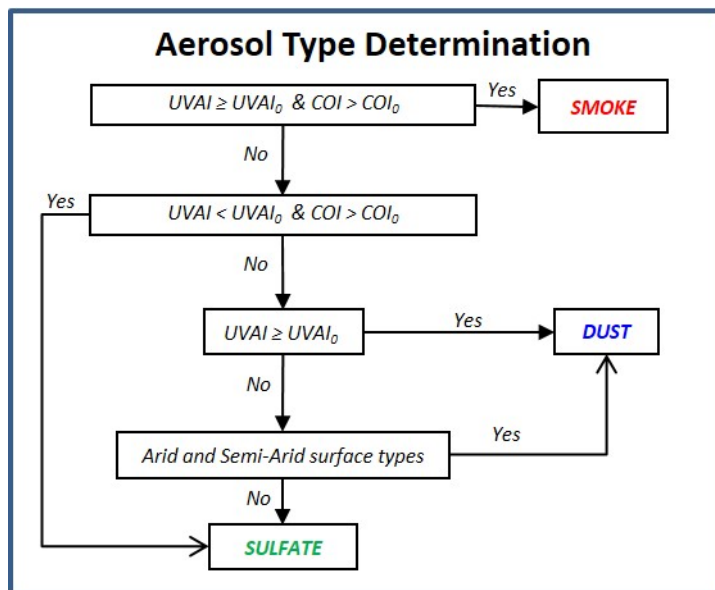


Figure 1. A flow diagram illustrating the aerosol type selection scheme.

### 2.3.3 Cloud Screening

Because of the coarse sensors resolution sub-pixel cloud contamination is the largest source of uncertainty in retrieved quantitative EPIC aerosol products. In the algorithm the level of cloud contamination is determined in a decision tree using a combination of thresholds in reflectivity,  $R_{SFC}$  and  $\Delta R$  ( $R_{SCE} - R_{SFC}$ ), COI and UVAI as shown in Fig. 2.

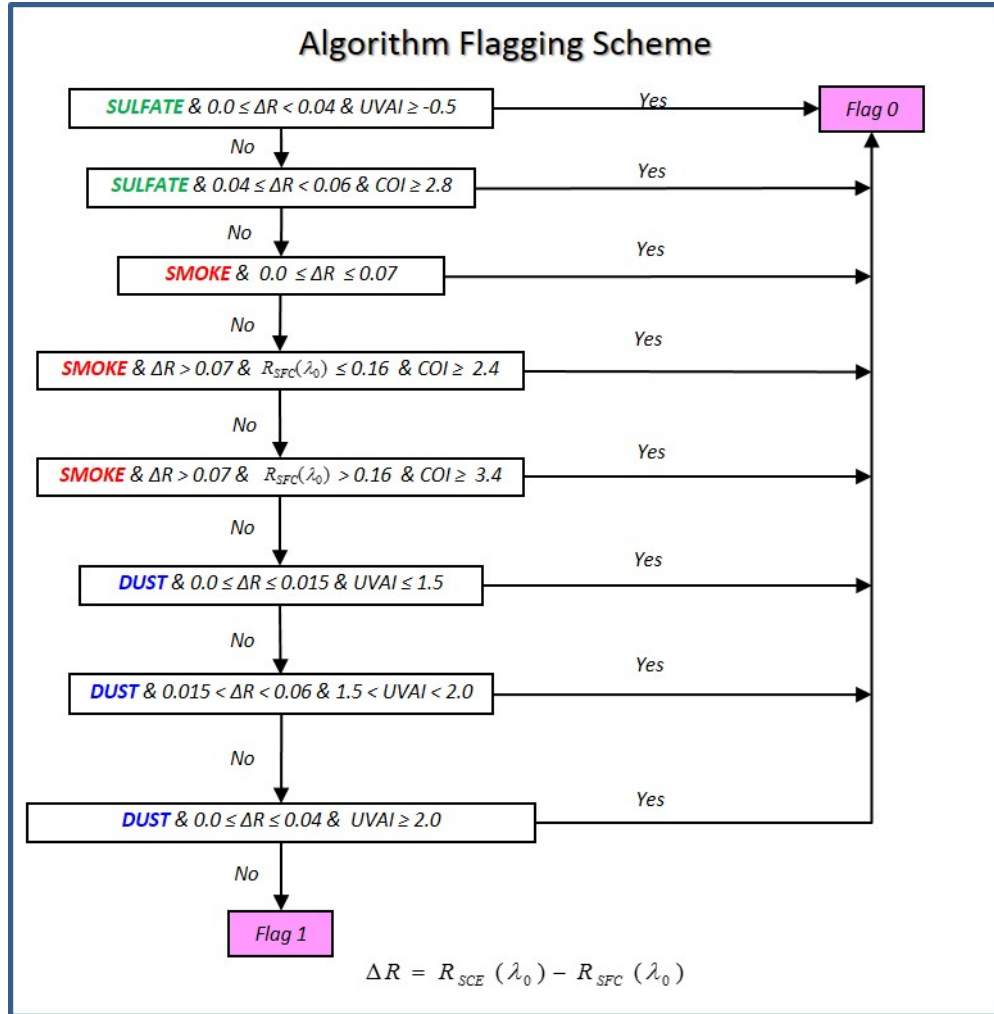


Figure 2. The criteria for identifying cloud-free pixels.

Algorithm quality Flags 0 and 1 assign a level of confidence to the retrieved parameters. Flag 0 (highest confidence) is assigned to retrieval conditions when minimum cloud contamination was detected, whereas Flag 1 is reported for conditions where cloud contamination is suspected. Although, the data is still reported for Flag 1 retrievals, its quantitative use is not recommended. Because cloud contamination affects AOD and single scattering co-albedo (1-SSA) in opposite directions, a partial cancellation of errors may take place in the calculation of AAOD.

### 2.3.4 Aerosol layer height

The assumed aerosol level height is extracted from the CALIOP height climatology for each pixel. Although the CALIOP climatology provides information on aerosol layer height for most of the globe, there may be instances when no data is available. In those cases, the choice of aerosol layer height for absorbing aerosol layers varies with aerosol type and location.

Carbonaceous aerosol layers within 30 degrees of the Equator are assumed to have maximum concentration at 3 km above ground level; whereas smoke layers at mid and high-

latitude (poleward of  $\pm 45^\circ$ ) are assumed to peak at 6 km. The height of smoke layers between  $30^\circ$  and  $45^\circ$  latitude in both hemispheres is interpolated between 3 and 6 km with latitude.

The height of desert dust aerosol layers varies between 1.5 and 10 km, and is taken from a multi-year climatological average of Chemical Model Transport (CTM) calculations using the GOCART model.

Value of <i>HeightFlags</i> data field	Source of aerosol layer height information
1	CALIOP Climatology
2	GOCART Climatology
3	Interpolated with latitude between 3 and 6 km
4	Assumed value (0.0, 1.5, 3.0, 6.0, or 10.0)

Table 2. The aerosol layer height determination.

For the sulfate-based aerosols, the algorithm considers that the aerosol concentration is largest at the surface and decreases exponentially with height. The *HeightFlags* dataset provides information on the source of aerosol layer height used in the AOD/SSA retrieval. Value of *HeightFlags* varies from 1 to 4 as shown in Table 2.

### 2.3.5 Inversion Scheme

Surface Category	AI	COI	Surface Type	Aerosol Type	Retrieved Parameters
Ocean	$\geq 1.0$	$>2.0$ NH (1.6 SH)	n/a	Smoke	AOD, SSA
Ocean	$\geq 1.0$	$\leq 2.0$ NH (1.6 SH)	n/a	Dust	AOD, SSA
Ocean	$< 1.0$	-	-	-	No retrieval
Land	$\geq 0.8$	$>2.0$ NH (1.6 SH)	All	Smoke	AOD, SSA
Land	$\geq 0.8$	$\leq 2.0$ NH (1.6 SH)	All	Dust	AOD, SSA
Land	$< 0.8$	$>2.0$ NH (1.6 SH)	All	Sulfate	AOD, SSA
Land	$< 0.8$	$\leq 2.0$ NH (1.6 SH)	All but arid	Sulfate	AOD, SSA
Land	$< 0.8$	$\leq 2.0$ NH (1.6 SH)	arid	Dust	AOD, SSA

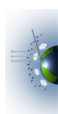
Table 3. The retrieval approach criteria.

A summary of the retrieval criteria and retrieved parameters is presented in Table 3. As stated, retrievals take place over land for all cloud-free conditions. In addition of cloud-free conditions, the AI must be greater than unity for ocean retrievals.

Retrieved values of AOD, AAOD and SSA are reported at 388 nm. Similar values are also reported at 340 nm and at 500 nm by conversion from the retrieval at 388 nm. The wavelength conversion from 388 nm to 340 nm and 500 nm is done using the spectral dependence associated with the assumed aerosol particle size distribution and retrieved absorption information.

### 2.3.6 Algorithm Flag

A simplified algorithm flag scheme has been implemented. Flag categories and their description are summarized in Table 4. Flags 0 and 1 qualify the reliability of reported retrieved parameters in terms of sub-pixel cloud contamination effects. Flag 1 is reported for conditions



where cloud contamination was suspected to be present. Although, the data is still reported for Flag 1 retrievals, its quantitative use is not recommended. Flags 3 through 7 indicate the occurrence of observational, geographical or environmental conditions preventing the retrieval of aerosol parameters and fill values for the retrieved parameters are reported in the respective pixel.

Flag	Description
<b>0</b>	Minimum sub-pixel cloud contamination. Most reliable retrievals(AOD, SSA, AAOD)
<b>1</b>	Possible Cloud contaminated retrievals, retrievals still reported.
<b>2</b>	No longer used.
<b>3</b>	Out-of-bounds SSA or AOD above 6.0 at 500nm.
<b>4</b>	Snow/ice contaminated data.
<b>5</b>	Solar Zenith Angle above threshold (70 degree).
<b>6</b>	Sun glint angle below threshold over water (40 degree).
<b>7</b>	Terrain Pressure below threshold (250.0 hPa).

Table 4. The algorithm flag scheme.

### 3. Product Description

The EPICAERUV products are Level 2 swath data files that follow a specific file naming convention and dataset organization. The components of file names are as follows:

File naming convention: DSCOV<sub>R</sub>\_EPIC\_L2\_AER\_VV\_YYMMNDDHHMMSS.he5

VV: Product Version (01)

YYYY: Year.

MN: Month.

DD: Day.

HHMMSS : EPIC measurement time in UTC of hour, minute, and second.

These files includes latitude, longitude, viewing geometry, best estimate values of AOD (variable name FinalAerosolOpticalDepth) and AAOD (variable name FinalAerosolAbsOpticalDepth) at 340, 388 and 500 nm associated with a reported particular choice of aerosol vertical distribution, and ancillary parameters used in the retrieval scheme as well as diagnostic flags. A very important parameter also reported is the algorithm quality flag (field name FinalAlgorithmFlags), which contains integer values indicating a confidence level in cloud screening. Most users should use data with quality flag 0 and 1 depending on their applications. Each product file in HDF-EOS5 contains a geolocation field group, and a data field group with following swath dimensions.

Swath Dimensions:

nXtrack - The dimension representing the cross-track positions (2048).

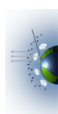
nTimes - The dimension representing the scan-line number (2048).

nLayers - The dimension representing the aerosol profile peak layer heights (5 layers: 0.0, 1.5, 3.0, 6.0, and 10.0 km) prescribed in Look-up tables.

nWavel - The dimension representing three wavelengths (340, 388, and 500 nm)

nWavel2 - The dimension representing two wavelengths (340, 388 nm).

A complete list of the parameters is as follows:

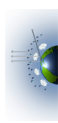


#### Geolocation Fields:

- Field Name: Latitude  
Data Type: HE5T\_NATIVE\_FLOAT  
Dimensions: nXtrack,nTimes  
Missing Value: -1.2676506e+30  
Description: >  
The geodetic latitude (in deg) at the center of the ground pixel.
- Field Name: Longitude  
Data Type: HE5T\_NATIVE\_FLOAT  
Dimensions: nXtrack,nTimes  
Missing Value: -1.2676506e+30  
Description: >  
The geodetic longitude (in deg) at the center of the ground pixel.
- Field Name: RelativeAzimuthAngle  
Data Type: HE5T\_NATIVE\_FLOAT  
Dimensions: nXtrack,nTimes  
Missing Value: -1.2676506e+30  
Description: >  
The relative (sun + 180 - view) azimuth angle (in deg) at the center of the ground pixel.
- Field Name: SolarZenithAngle  
Data Type: HE5T\_NATIVE\_FLOAT  
Dimensions: nXtrack,nTimes  
Missing Value: -1.2676506e+30  
Description: >  
The solar zenith angle (in deg) at the center of the ground pixel.
- Field Name: TerrainPressure  
Data Type: HE5T\_NATIVE\_FLOAT  
Dimensions: nXtrack,nTimes  
Missing Value: -1.2676506e+30  
Description: >  
The terrain pressure (in hPa) at the center of the ground pixel.
- Field Name: SnowIce\_fraction  
Data Type: HE5T\_NATIVE\_FLOAT  
Dimensions: nXtrack,nTimes  
Missing Value: -1.2676506e+30  
Description: >  
The Snow/Ice\_fraction (in %) at the center of the ground pixel.

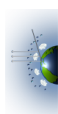
#### Data Fields:

- Field Name: FinalAerosolLayerHeight  
Data Type: HE5T\_NATIVE\_FLOAT  
Dimensions: nXtrack,nTimes  
Missing Value: -1.2676506e+30  
Description: >  
The aerosol layer height (in km) associated with the ground pixel.



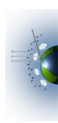
- Field Name: AerosolSingleScattAlbVsHeight  
 Data Type: HE5T\_NATIVE\_FLOAT  
 Dimensions: nWavel,nLayers,nXtrack,nTimes  
 Missing Value: -1.2676506e+30  
 Description: >  
 The aerosol single scattering albedo solution associated with the ground pixel for five (5) aerosol layer heights.
  
  - Field Name: AerosolAbsOpticalDepthVsHeight  
 Data Type: HE5T\_NATIVE\_FLOAT  
 Dimensions: nWavel,nLayers,nXtrack,nTimes  
 Missing Value: -1.2676506e+30  
 Description: >  
 The aerosol absorption optical depth solution associated with the ground pixel for five (5) aerosol layer heights.
  
  - Field Name: AerosolOpticalDepthVsHeight  
 Data Type: HE5T\_NATIVE\_FLOAT  
 Dimensions: nWavel,nLayers,nXtrack,nTimes  
 Missing Value: -1.2676506e+30  
 Description: >  
 The aerosol optical depth solution associated with the ground pixel for five (5) aerosol layer heights.
  
  - Field Name: AerosolType  
 Data Type: HE5T\_NATIVE\_UINT8  
 Dimensions: nXtrack,nTimes  
 Missing Value: 255  
 Description: >  
 The aerosol type associated with the ground pixel.  
 1 - Smoke  
 2 - Dust  
 3 - Sulfate  
 255 - Unknown
  
  - Field Name: FinalAlgorithmFlags  
 Data Type: HE5T\_NATIVE\_UINT16  
 Dimensions: nXtrack,nTimes  
 Missing Value: 65535  
 Description: >  
 The final algorithm flag associated with the ground pixel:
- Aerosol extinction Optical Depth (AOD), Single Scattering Albedo (SSA),  
 and Aerosol Absorption Optical Depth (AAOD)  
 Retrievals:  
 0 - Most reliable  
 1 - Less Reliable  
 2 - Unused

Not Reliable/No Retrievals:

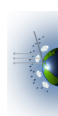


- 3 - Out-of-bounds SSA or AOD above 6.0 at 500nm.
- 4 - Cloud/snow/ice contaminated data.
- 5 - Solar Zenith Angle above threshold (80 degrees).
- 6 - Sun glint angle below threshold over water (40 degrees).
- 7 - Terrain Pressure below threshold (250.0 hPa).

- Field Name: AlgorithmFlagsVsHeight  
 Data Type: HE5T\_NATIVE\_UINT16  
 Dimensions: nLayer,nXtrack,nTimes  
 Missing Value: 65535  
 Description: >  
 The algorithm flag associated with the ground pixel for each height:  
 Aerosol Single Scattering Albedo (SSA) and Aerosol Absorption Optical Depth (AAOD)  
 Retrievals for each height:  
 The same criteria used for the FinalAlgorithmFlags are applied for each height.
  
- Field Name: FinalAerosolSingleScattAlb  
 Data Type: HE5T\_NATIVE\_FLOAT  
 Dimensions: nWavel,nXtrack,nTimes  
 Missing Value: -1.2676506e+30  
 Description: >  
 The best aerosol single scattering albedo solution associated with the ground pixel.
  
- Field Name: FinalAerosolOpticalDepth  
 Data Type: HE5T\_NATIVE\_FLOAT  
 Dimensions: nWavel,nXtrack,nTimes  
 Missing Value: -1.2676506e+30  
 Description: >  
 The best aerosol optical depth solution associated with the ground pixel.
  
- Field Name: FinalAerosolAbsOpticalDepth  
 Data Type: HE5T\_NATIVE\_FLOAT  
 Dimensions: nWavel,nXtrack,nTimes  
 Missing Value: -1.2676506e+30  
 Description: >  
 The best aerosol absorption optical depth solution associated with the ground pixel.
  
- Field Name: ImaRefractiveIndex  
 Data Type: HE5T\_NATIVE\_FLOAT  
 Dimensions: nWavel,nLayers,nXtrack,nTimes  
 Missing Value: -1.2676506e+30  
 Description: >  
 The imaginary component of the refractive index solution associated with the ground pixel.
  
- Field Name: NormRadiance  
 Data Type: HE5T\_NATIVE\_FLOAT  
 Dimensions: nWavel2,nXtrack,nTimes  
 Missing Value: -1.2676506e+30  
 Description: >  
 The Normalized Radiance is the Radiance / Irradiance ratio.



- Field Name: Reflectivity  
 Data Type: HE5T\_NATIVE\_FLOAT  
 Dimensions: nWavel2,nXtrack,nTimes  
 Missing Value: -1.2676506e+30  
 Description: >  
 The Lambert equivalent reflectivity associated with the ground pixel.
  
- Field Name: Wavelength  
 Data Type: HE5T\_NATIVE\_FLOAT  
 Dimensions: nWavel  
 Missing Value: -1.2676506e+30  
 Description: >  
 The wavelengths associated with the ground pixel.
  
- Field Name: SurfaceType  
 Data Type: HE5T\_NATIVE\_UINT16  
 Dimensions: nXtrack,nTimes  
 Missing Value: 65535  
 Description: >  
 The surface type associated with the ground pixel.
  
- Field Name: SurfaceAlbedo  
 Data Type: HE5T\_NATIVE\_FLOAT  
 Dimensions: nWavel2,nXtrack,nTimes  
 Missing Value: -1.2676506e+30  
 Description: >  
 The surface albedo associated with the ground pixel.
  
- Field Name: UVAerosolIndex  
 Data Type: HE5T\_NATIVE\_FLOAT  
 Dimensions: nXtrack,nTimes  
 Missing Value: -1.2676506e+30  
 Description: >  
 The UV aerosol index associated with the ground pixel.
  
- Field Name: AlgorithmFlags\_AerosolIndex  
 Data Type: HE5T\_NATIVE\_UINT16  
 Dimensions: nXtrack,nTimes  
 Missing Value: 65535  
 Description: >  
 Flags indicate possible algorithmic swithes applied in the Aerosol Index:
  - Bit 0 - Glint angles less than 20 degree
  - Bit 1 - Cloud fraction less than 0.0
  - Bit 2 - Cloud fraction equal to 1.0
  - Bit 3 - Snow/ice covered pixels
  - Bit 4 - Cloud optical depth equal to 100.0
  
- Field Name: Residue  
 Data Type: HE5T\_NATIVE\_FLOAT  
 Dimensions: nXtrack,nTimes  
 Missing Value: -1.2676506e+30



Description: >

The residue associated with the ground pixel.

- Field Name: HeightFlags
- Data Type: HE5T\_NATIVE\_UNINT8
- Dimensions: nXtrack,nTimes
- Missing Value: 255
- Description: >
  - 1 - CALIOP climatology
  - 2 - GOCART climatology
  - 3 - Interpolated in between 3 - 6 km within +/- 30 - 45 degree latitudes
  - 4 - Assumed (0.0 or 1.5 or 3.0 or 6.0 or 10.0 km).

The flag of aerosol layer height source associated with the ground pixel.

- Field Name: AIRSL3COvalue
- Data Type: HE5T\_NATIVE\_FLOAT
- Dimensions: nXtrack,nTimes
- Missing Value: -9999.0
- Description: >

The AIRS Carbon Monoxide (molecules/cm<sup>2</sup>) value associated with the ground pixel.

## 4. Contacts

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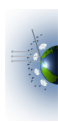
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